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ABSTRACT

The relationship of cognitive style variables and conditions of test administration was investigated in cognitive assessments of hearing-impaired children, aged six through eleven. One hundred-twenty children were given the Raven Coloured Progressive Matrices (CPM) and a Piagetian battery under one of six conditions of testing: (1) standard; (2) simple feedback; (3) verbalization after problem solution; (4) verbalization during and after solution; (5) differential feedback; and (6) conditions 4 and 5 combined. Kagan's Matching Familiar Figures Test (MFFT) and the Nowicki-Strickland Locus of Control Scale were also administered. Performance under conditions 5 and 6 was greater than performance under conditions 3 and 4, which in turn exceeded performance under conditions 1 or 2. Criterion-related validity was significantly enhanced under all - elaborative conditions. MFFT latency, MFFT errors, and locus of control scores were differentially related to performance in the different testing conditions. The overall prediction equation explained CPM and Piagetian test performance under conditions 2, 4, and 5. All analyses indicated consistency of findings across both dependent measures. (Author/MH)

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The Relationship of Cognitive Style Variables to Optimal Test Performance in Hearing-Impaired Children

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Running Head: Cognitive Style and Optimal Test Performance

Abstract

One hundred-twenty hearing-impaired children ages 6-11 were given the Raven Coloured Progressive Matrices (CPM) and a Piagetian battery under one of six conditions of testing: (a_1) standard, (a_2) simple feedback, (a_3) "verbalization" after problem solution, (a_4) "verbalization" during and after solution, (a_5), differential feedback, and (a_6) conditions a_4 and a_5 combined. Kagan's Matching Familiar Figures Test (MFFT) and the Nowicki-Strickland Internal-External Control scale were also administered.

Performance under conditions a_5 and a_6 was greater than performance under conditions a_3 and a_4, which in turn exceeded performance in conditions a_1 or a_2. Criterion-related validity was significantly enhanced under all elaborative conditions.

MFFT latency, MFFT errors, and locus of control scores were differentially related to performance in the different testing conditions. The overall prediction equation explained CPM and Piagetian test performance under conditions a_2, a_4, and a_5. All analyses indicated consistency of findings across both dependent measures.

The Relationship of Cognitive Style Variables to Optimal Test Performance in Hearing-Impaired Children

The difficulty of gaining accurate cognitive assessments among hearing-impaired children has been an issue of considerable recent concern among researchers and educators. Hearing-impaired persons have experiential backgrounds which cannot be equated with those of their hearing counterparts (Stokoe, 1976). Hearing-impaired persons may lack task-relevant experiences, with the result that standard methods of test administration may not yield veridical assessments of the individual's developing knowledge and abilities. Thus, beyond the shortcomings of standardized tests themselves, e.g., item bias (Rudner, 1978), the manner in which tests of cognitive abilities are typically administered may not be wholly appropriate for hearing-impaired persons.

An assumption underlying the use of standard methods of test administration is that all individuals can be suitably assessed under the same testing condition. No consideration is given to the possibility that aspects of a given testing condition may detrimentally interact with aspects of an individual's personality or cognitive style.

The testing-the-limits paradigm guiding the present investigation involves the use of a series of elaborative testing conditions. In contrast to the standard manner in which tests of cognitive abilities such as the Raven Coloured Progressive Matrices (CPM; Raven, 1962) and

Piagetian items (Winklemann, 1975) employed in the present investigation are administered, wherein the individual being tested is permitted to passively respond to test items, the use of elaborative procedures necessitates the examinee's active involvement in the testing situation in such a way that the elaboration of existing cognitive organization is facilitated. Previous work has indicated that elaborative procedures result in enhanced performance for hearing-impaired (Carlson & Dillon, 1978) and educable mentally retarded (Carlson & Wiedl, 1978) children, and enhanced performance and criterion-related validity for hearing children (Carlson & Dillon, in press; Carlson & Wiedl, 1976; Dillon & Carlson, 1978) on Piagetian and Raven matrices tasks. In addition, results of one investigation (Carlson & Wiedl, 1976) identified the interaction of elaborative procedures and dimensions of cognitive style in hearing children.

The present investigation was designed to (a) examine the effects of method of test administration on performance and criterion-related validity, and (b) investigate the interaction of selected cognitive style variables and varying conditions of test administration. This study constituted the first reported attempt to consider the relationship of cognitive style variables and conditions of test administration in cognitive assessments on hearing-impaired children.

Method

Sample

One hundred-twenty children were tested, ranging from 6-11 years old ($\bar{X}$ = 9.0, σ = 1.5) and having a hearing loss of at least 80 decibels in the frequencies where most speech sounds are produced (i.e., 500, 1,000 and

2,000 cycles per second). Children included in the sample possessed no additional known handicapping conditions and had an age of onset of deafness of prior to 6 months.

Materials

1. The CPM (Raven, 1956) was administered to all children. The CPM consisted of 36 items. Each item showed a stimulus array or puzzle in which a portion or "piece" was missing. The examinee was instructed to find, from a set of six distractors, the correct piece that completed the stimulus array. Correct responses were given a score of 1, incorrect responses a score of 0.

2. A Piaget-derived test battery (Winklemann, 1975), consisting of multiplicative classification (matrices), order of appearance and seriation items was also given to all children. The test contained eight multiplicative classification items. Each test item consisted of a 3 x 3 or 4 x 4 stimulus array. The task was to complete the two-dimensional array by choosing the correct piece from among eight choices. The test contained 16 order of appearance items. Each item showed a set of three differently coloured balls located in a "house". Attached to the house was a tube that varied in number of convolutions through which the subject was told to imagine the balls would pass. The examinee was to select from a set of six distractors the picture which showed how the balls would look after they were rolled from the far end of the tube to their house at the other end of the tube. There were 12 asymmetrical seriation items. In each item, the examinee was presented with a variety of serial arrangements of objects of different lengths and sizes. The task was to order the objects according to increasing or decreasing size,

depending on the particular item.

3. Individual differences in conceptual tempo (reflection-impulsivity) were assessed by the Matching Familiar Figures Test (MFFT; Kagan, Moss, & Sigel, 1963). The examinee was shown a picture of a familiar object and six similar variants, only one of which was identical to the standard. The examinee was asked to select the identical picture. Latency to the first response and number of errors overall, taken separately, were the criterion measures. Due to methodological shortcomings of the double median split procedure, the two measures were considered as independent continuous variables.

4. Individual differences in locus of control were assessed by means of the shortened form of the Nowicki-Strickland Internal-External Control Scale (Nowicki and Strickland, 1973). The test was a paper-and-pencil measure containing 19 items of an agree-disagree format. All items were rephrased, with sentences truncated and negatives removed (see Appendix A).

Procedures

Children were randomly assigned to one of six testing conditions. The children were tested individually, with order of test administration being randomly assigned. All testing was conducted using Total Communication. The CPM and Piagetian battery were administered under the following conditions: (1) standard, (2) simple feedback, (3) child's "verbalization" following solution of each test item, (4) child's "verbalization" during and after item solution, (5) differential feedback given by the examiner following each choice, and (6) child's "verbalization" during and after solution coupled with differential feedback.

Both cognitive style measures were administered according to standard procedures only.

Results

Table 1 displays means and standard deviations of scores on the CPM and Piagetian tasks for examinees assigned to one of six testing conditions (a_1, standard; a_2, simple feedback; a_3, child's verbalization after problem solution; a_4, verbalization during and after solution; a_5, elaborated feedback; and a_6, verbalization during and after solution coupled with elaborated feedback). Verbalization, in the context of

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Insert Table 1 about here

Total Communication, involved simultaneous speech and signing.

The analysis of variance (Winer, 1971) indicated that the groups' means differed, F (1, 114) = 9.86, $p < .001$. Planned orthogonal comparisons and Scheffé contrasts indicated that performance under fully elaborated conditions (a_5 and a_6) was greater than performance under partially elaborated procedures (a_3 and a_4), and under partially elaborative as compared to nonelaborative procedures (a_1 and a_2). All differences were significant at $p < .05$. Performance under the two fully elaborative conditions failed to differ, as did performance under the two partially elaborative conditions. Performance under the two nonelaborative conditions also failed to differ. The same pattern of findings was noted for the CPM and the Piagetian battery.

Pearson product-moment correlation coefficients and corresponding tests for the significance of each correlation were employed to investigate

the relationship of performance on the criterion measures administered under the six testing conditions to teacher judgement of overall reasoning ability. The drawbacks of using teacher ratings and rankings as criteria of school-related performance have been considered (e.g., Popham, 1975), as have problems associated with the use of standardized tests of school achievement with the hearing-impaired (Rudner, 1978). The teacher judgement criterion was selected as the most appropriate index available, in that the measure was needed to validate criterion measures designed to tap the cognitive competence actually possessed by individuals. Standardized tests of school achievement seemed inappropriate for this purpose in light of evidence that such tests often sorely underestimate a hearing-impaired child's conceptual abilities (Meadow, 1975).

With respect to the CPM, the relationship of teacher judgement to task performance fails to exceed chance expectations for either nonelaborative condition. The correlations under the fully elaborative conditions, which are .26 and .28, respectively, yield F values less than $< .10$ in both cases. As useful information may be gained through direct replication where warranted, values between .05 and .10 are reported although they fall short of statistical significance by current research convention. A correlation of .41 ($p < .05$) is found under $\underline{a}_3$.

With respect to the Piagetian battery as related to teacher judgement, again relationships do not exceed chance expectations for the nonelaborative conditions. Correlations of .23 and .27 are found for $\underline{a}_3$ and $\underline{a}_6$, respectively, approaching significance at $p < .10$ in both cases. A value of .52 ($p < .05$) is found under $\underline{a}_5$. As with CPM

performance, a_4 is the only elaborative condition under which the variables are not significantly positively correlated.

Correlations between CPM score and teacher judgement increase under elaborative procedures compared to nonelaborative conditions for the Piagetian battery ($z = 4.41$, $p < .001$). A similar tendency is identified for the CPM ($z = 1.55$, $p < .10$).

A Guttman split-half reliability of .48 was found for the 19-item locus of control scale. Applying the Spearman-Brown Prophecy Formula to correct for test length (Nunnally, 1967), where $r_{11} = .48$ with 19 items, an estimated reliability of .70 results from the addition of 21 items of comparable quality.

Reliabilities were computed for both latency and errors on the MFFT. A Cronbach Alpha of .89 was found for latency. A Cronbach Alpha of .20 was found for MFFT errors.

Correlational and multiple regression analyses were employed to examine the relationships of locus of control score, MFFT latency and MFFT errors on CPM and Piagetian task performance. With respect to the CPM, the negative effects of errors on a test of cognitive impulsivity are maximized under a_2 and a_5 ($r = -.817$ and $-.758$ for MFFT errors, $p < .001$ in both cases) and minimized under a_3 and a_6. For the Piagetian battery, the negative effects of errors on a test of cognitive impulsivity are again maximized under a_2 and a_5 ($r = -.715$ and $r = -.687$, respectively, for MFFT errors, $p < .001$) and minimized under a_3. The effects of locus of control are maximized under a_5 ($r = .49$, $p < .05$) and minimized under a_2 and a_4 for the CPM. For the Piagetian test, the effects of locus of control are maximized under a_3 (although not

statistically significant) and minimized under $\underline{a}_2$ and $\underline{a}_4$.

Multiple regression analyses were employed to assess the amount of variance in performance explained by the cognitive style variables. Separate analyses were conducted with CPM and Piagetian score, obtained under each of the six conditions, used as criterion variables, and MFFT latency, MFFT errors, and locus of control score used as predictors. A forward selection prodedure was employed (SPSS; Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975).

For the CPM, MFFT errors account for the greatest proportion of explained variance under $\underline{a}_1$ and $\underline{a}_4$ (ΔR^2 = .187 and .247, respectively, $p < .05$) and $\underline{a}_2$ and $\underline{a}_5$ (ΔR^2 = .662 and .547, respectively, $p < .001$), with locus of control accounting for the greatest amount of variance under $\underline{a}_3$ and $\underline{a}_6$ (ΔR^2 = .220, $p < .05$). For the Piagetian battery, MFFT errors account for the greatest proportion of variance under $\underline{a}_1$, $\underline{a}_4$, $\underline{a}_5$, and $\underline{a}_6$ (ΔR^2 = .234, .223, .471, .224, respectively, $p < .05$) and $\underline{a}_2$ (ΔR^2= .591. $p < .001$). Locus of control is the salient predictor under $\underline{a}_3$ (ΔR^2 = .30, $p < .05$). For the CPM, the overall prediction equation is significant for $\underline{a}_2$, accounting for 67% of the variance in performance ($F = 10.66$, $df = 3/16$, $p < .001$). A similar finding is noted for $\underline{a}_2$ performance on the Piagetian items, with 61% explained variance ($F = 8.34$, $df = 3/16$, $p < .01$). The prediction equation accounts for 42% of the variance in CPM performance under $\underline{a}_4$ ($F = 3.85$, $df = 3/16$, $p < .05$). The equation is not predictive of Piagetian performance under $\underline{a}_4$. The overall prediction equation accounts for a significant proportion of the variance in performance under $\underline{a}_5$ on both the CPM and Piagetian tasks, accounting

for 68% ($F = 11.11$, $df = 3/16$, $p < .001$) on the former task and 58% ($F = 7.26$, $df = 3/16$, $p < .01$) on the latter. The equation is not predictive of CPM or Piagetian performance under $\underline{a}_6$.

Discussion

Performance of hearing-impaired children is enhanced on Piagetian and Raven matrices tasks under partially elaborative as compared to nonelaborative testing conditions, and under fully elaborative as opposed to partially elaborative procedures. Criterion-related validity of the tests for hearing-impaired children is significantly enhanced under elaborative conditions of testing, when teacher judgements of ability serve as the criterion measures.

MFFT latency, errors, and locus of control score are differentially related to performance under the six conditions. The effects of cognitive impulsivity are maximized under $\underline{a}_2$ and $\underline{a}_5$ and minimized under $\underline{a}_3$. The importance of locus of control is maximized under $\underline{a}_5$ for the CPM and $\underline{a}_3$ for the Piagetian battery, and minimized under $\underline{a}_2$ and $\underline{a}_4$ for both tasks. Errors accounted for the largest proportion of explained variance, with the overall prediction equation being significant under $\underline{a}_2$, $\underline{a}_4$, and $\underline{a}_5$ for the CPM, and $\underline{a}_2$ and $\underline{a}_5$ for the Piagetian task. Thus, performance on tasks of logical abilities is significantly and negatively affected by errors on a task of cognitive impulsivity.

A Cronbach Alpha of .20 for MFFT errors, while low, corresponds to estimates reported in the literature with hearing samples. Thus, the cautions recommended by Ault, Mitchell, & Hartman (Note 1) with studies employing hearing samples appear to be pertinent to the study of hearing-impaired children as well.

For cognitive assessments to be maximally veridical (i.e., to approximate actual competence as closely as possible), a differential approach to assessment is called for. However, no statements can be made to the effect that elaborative testing conditions increase or decrease the effect of individual differences relative to nonelaborative conditions. Rather, prescriptions should pertain to constituent processes or aspects of each particular condition as these relate to aspects of personality or cognitive style. For example, conditions involving simple feedback and differential feedback both maximize the effects of errors in responding on a task of cognitive impulsivity, even though the former condition is essentially nonelaborative, while the latter is elaborative. While elaborative procedures should enhance performance and criterion-related validity relative to nonelaborative conditions, this is only the case to the extent that the procedures selected capitalize on strengths or minimize the effects of weaknesses along relevant dimensions.

The efficacy of the testing-the-limits approach with hearing-impaired children points to the robustness of the testing paradigm with respect to changes in population, as previous research has indicated its importance for assessments on normal hearing and educable mentally retarded persons. Thus, the procedures advocated are not tied to a particular subject group or to a particular testing instrument. The findings of the previously cited investigations, coupled with data from the present investigation, indicate that cognitive abilities which an individual possesses may not be adequately tapped under standard testing procedures.

The findings of this investigation may be used as an aid in the

development of diagnostic instruments and procedures which take individual differences along dimensions of personality and cognitive style into account. By facilitating accurate cognitive assessments, the research findings may also be useful in determining the extent to which given individuals may profit from particular modes of instruction.

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Table 1

Means and Standard Deviations for all Testing Conditions on Coloured Progressive Matrices Scores and on Piagetian Scores

		CPM		Piagetian Task	
Condition	N	Mean	SD	Mean	SD
Condition a_1	20	19.65	8.10	15.80	8.43
Condition a_2	20	19.30	8.03	17.45	8.28
Condition a_3	20	26.60	6.00	22.20	6.32
Condition a_4	20	26.30	5.30	22.35	3.84
Condition a_5	20	28.30	4.99	26.20	6.42
Condition a_6	20	29.65	4.34	26.40	5.33

Appendix A

Modifications in Locus of Control Items

Locus of Control Items

1. Do you believe that most problems will solve themselves if you just don't fool with them?
2. Do you feel that most of the time it doesn't pay to try hard because things never turn out right anyway?
3. Do you feel that most of the time parents listen to what their children have to say?
4. Do you believe that wishing can make good things happen?
5. Do you feel that it's nearly impossible to change your parent's mind about anything?
6. Do you feel that when you do something wrong there's very little you can do to make it right?
7. Do you believe that most kids are just born good at sports?
8. Are most of the other kids your age stronger than you are?
9. Do you feel that one of the best ways to handle most problems is just not to think about them?
10. Do you feel that when a kid your age decides to hit you, there's little you can do to stop him or her?
11. Have you felt that when people were mean to you it was usually for no reason at all?
12. Do you believe that when bad things are going to happen they just are going to happen no matter what you try to do to stop them?
13. Most of the time, do you find it useless to try to get your own way at home?

14. Do you feel that when somebody your age wants to be your enemy there's little you can do to change matters?
15. Do you usually feel that you have little to say about what you get to eat at home?
16. Do you feel that when someone doesn't like you there's little you can do about it?
17. Do you usually feel that it's almost useless to try in school because most other children are just plain smarter than you are?
18. Are you the kind of person who believes that planning ahead makes things turn out better?
19. Most of the time, do you feel that you have little to say about what your family decides to do?

Modifications in Locus of Control Items

1. Do you think problems will fix themselves if you leave them alone?
2. Do you think trying hard makes things happen right? (reverse)
3. Do parents listen to what their children say?
4. Do you think wishing can make good things happen?
5. Can you change what your parents think about things? (reverse)
6. When you do wrong things, can you make them right? (reverse)
7. Are most kids born good at games like baseball and football?
8. Are most kids your age stronger than you?
9. Do you think that the best way to work problems is to forget about them?
10. When a kid your age wants to hit you, can you stop him? (reverse)
11. When people are mean to you, do they have a good reason? (reverse)
12. Can you stop bad things from happening? (reverse)
13. Most of the time, do you get your own way at home? (reverse)
14. When a kid your age doesn't want to be your friend, can you change his mind? (reverse)
15. Do you have a lot to say about what you have to eat at home? (reverse)
16. Do you think that if a person doesn't like you that you can make him (her) like you? (reverse)
17. If you try hard in school, do things become better? (reverse)
18. Do you think that if you plan for the future that it makes good things happen?
19. Do you help decide what your family does? (reverse)